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CSCI 44800 Term Project: Shoulder Shrugging Event Detection

1. Objective
The objective of this project is to develop a robust system for detecting shoulder shrug events in videos. The system classifies shrugs as either "normal" or "exaggerated" based on their duration and evaluates its performance using Receiver Operating Characteristic (ROC) curves.

2. Problems/Issues
The primary challenges include:

- Accurately detecting shoulder movements in varying lighting and video quality.
- Differentiating between normal and exaggerated shrugs based on duration.
- Minimizing false positives and false negatives in shrug detection.
- Validating the system's performance using ground truth data.

3. Methodology
The system uses computer vision techniques to detect shoulder movements and classify shrugs. Key methods include:

- **Face Detection**: Haar Cascade Classifier is used to locate the face and define regions of interest (ROIs) for shoulder detection.
- **Edge Detection**: Canny edge detection is applied to identify shoulder contours within the ROIs.
- **Movement Analysis**: Gaussian smoothing is used to track shoulder movement over time, and thresholds are applied to detect significant movements.
- **Classification**: Shrugs are classified as "normal" or "exaggerated" based on their duration (threshold: 0.40 seconds).
- **Performance Evaluation**: ROC curves are generated to evaluate the system's ability to distinguish between true positives and false positives.

4. Experimental Design and Data
The system was tested on three videos containing annotated ground truth data for shrug events. Each video was processed frame-by-frame to detect shrugs, and the detected events were compared against the ground truth. The system outputs the time, duration, and classification of each detected shrug. The ROC curves were generated by varying the time threshold for matching detected events with ground truth.

5. Validation
The system's performance was validated using ROC curves for each video. The Area Under the Curve (AUC) values ranged from 0.78 to 0.85, indicating good performance in distinguishing true shrug events from false positives. The ROC curves demonstrate the trade-off between sensitivity (True Positive Rate) and specificity (False Positive Rate) at different thresholds.

6. References
[1] Viola, P., & Jones, M. (2001). Rapid object detection using a boosted cascade of simple features. In *Proceedings of the 2001 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR)* (Vol. 1, pp. I-I). IEEE.
[2] Canny, J. (1986). A computational approach to edge detection. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, (6), 679-698.
[3] Fawcett, T. (2006). An introduction to ROC analysis. *Pattern Recognition Letters*, 27(8), 861-874.